

MICHIGAN STATE
UNIVERSITY

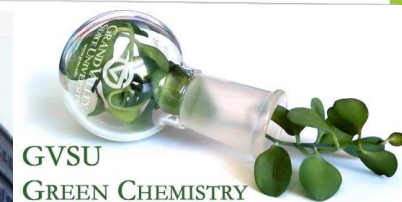
greenUp

Michigan Green Chemistry and Engineering Conference
Cultivating Next Generation Solutions

MICHIGAN STATE
UNIVERSITY



Michigan Tech
Create the Future



beyondbenign
green chemistry education

MICHIGAN
GREEN CHEMISTRY CLEARINGHOUSE





The Green Chemistry Commitment

TRANSFORMING CHEMISTRY EDUCATION

The **Green Chemistry Commitment (GCC)** is a consortium program that unites the green chemistry community around shared goals and a common vision to:

- expand the community of green chemists
- grow departmental resources
- improve connections to industry and job opportunities in green chemistry
- affect systemic and lasting change in chemistry education

www.greenchemistrycommitment.org



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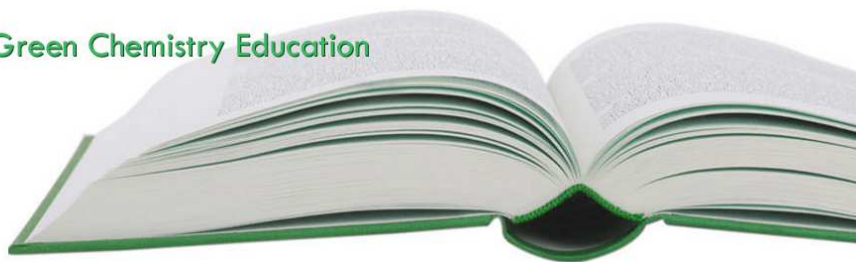
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The supporting organization for the Green Chemistry Commitment is Beyond Benign, a non-profit organization, founded in 2007 by Dr. John Warner and Dr. Amy Cannon, located north of Boston (Wilmington, MA).

Beyond Benign's vision is to revolutionize the way chemistry is taught to better prepare students to engage with their world while connecting chemistry, human health and the environment.

Green Chemistry Education



<http://www.beyondbenign.org/professional/academia.html>



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Why the Green Chemistry Commitment?

- ▶ A built-in support network with a flexible framework
- ▶ The power of a collective voice
- ▶ To share best practices
- ▶ Encouragement to move forward
- ▶ Developed by green chemistry practitioners
- ▶ Track a department's progress towards adoption of key student learning objectives



How to commit?

Green Chemistry Commitment is

- Voluntary
- Flexible
- Tracks the progress toward adoption GC theory & practice
- Based on your own institution resources and capabilities

Your department agrees to:

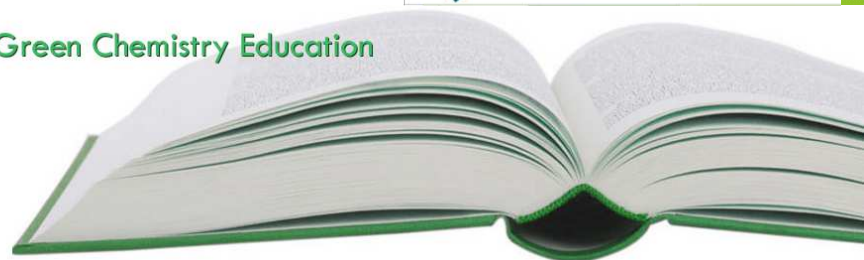
- Progressively incorporate Green Chemistry Student learning objectives
- Submit a streamlined annual report (new on-line form available through the website!)



The Green Chemistry Commitment
TRANSFORMING CHEMISTRY EDUCATION



Green Chemistry Education





The Green Chemistry Commitment

TRANSFORMING CHEMISTRY EDUCATION

The Green Chemistry Student Learning Objectives

Signing institutions agree that upon graduation, all chemistry majors should have proficiency in the following essential **green chemistry competencies**:

- **Theory:** Have a working knowledge of the twelve principles of Green Chemistry
- **Toxicology:** Have an understanding of the principles of toxicology, the molecular mechanisms of how chemicals affect human health and the environment, and the resources to identify and assess molecular hazards
- **Laboratory Skills:** Possess the ability to assess chemical products and processes and design greener alternatives when appropriate
- **Application:** Be prepared to serve society in their professional capacity as scientists and professionals through the articulation, evaluation and employment of methods and chemicals that are benign for human health and the environment





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The *Green Chemistry Student Learning Objectives* can be carried out through a number of different formats including, but not limited to:

- **Revision of existing departmental curriculum:**
 - Embed green chemistry throughout chemistry courses
 - Include green chemistry exercises throughout laboratory courses
 - Incorporate green chemistry principles into research projects and programs
 - Build toxicology and environmental health science modules into existing chemistry courses
- **Creation of new departmental curriculum:**
 - Develop new courses dedicated to green chemistry
 - Design toxicology and environmental health science courses
 - Develop a seminar series on green chemistry and/or toxicology
- **Utilization of other institutional or external resources:**
 - Encourage students to take elective courses in toxicology and/or environmental health sciences from other departments or institutions





MICHIGAN GREEN CHEMISTRY CLEARINGHOUSE

[INTERACT](#)[Spotlight on Michigan](#)[Education](#)[Public](#)[Industry](#)[Government](#)[Toolbox](#)[Funding & Incentives](#)

Michigan Green Chemistry Education Network

Related Pages
[Green Chemistry Self-Evaluation Form](#)



MI Green Chemistry Education Network



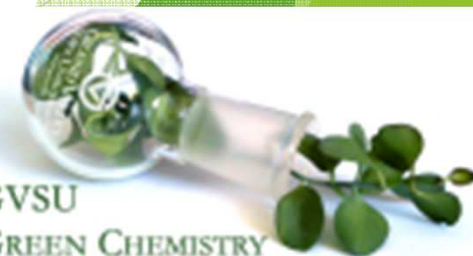


The Green Chemistry Commitment

TRANSFORMING CHEMISTRY EDUCATION

Courses: Green Chemistry content

CHM 102	<i>Chemistry and Society</i>	<i>lecture</i>
CHM 225	<i>Instrumental analysis</i>	<i>lab</i>
CHM 231	<i>Introductory Organic Chemistry</i>	<i>lab</i>
CHM 241	<i>Organic Chemistry</i>	<i>lab</i>
CHM 248	<i>Organic Chemistry (majors)</i>	<i>lab</i>
CHM 321	<i>Environmental Chemistry</i>	<i>lecture</i>
CHM 322	<i>Environmental Chemistry</i>	<i>lab</i>
CHM 344	<i>Qualitative Organic Analysis</i>	<i>lab</i>
CHM 355/455	<i>Physical Chemistry 2nd semester</i>	<i>lab</i>
CHM 399	<i>Independent studies: Reading in chemistry</i>	



HAZARDOUS WASTE	
Check All that Apply	
<input type="checkbox"/> Organic Solvents:	<input type="checkbox"/> Non-Halogenated <input type="checkbox"/> Halogenated
<input type="checkbox"/> Organic, Non-Hazardous: RCRA Exempt, Flash Pt. $\geq 140^{\circ}\text{F}^*$	
<input type="checkbox"/> Hazardous Metals: As, Ba, Cd, Cr, Pb, Se, Ag	
<input type="checkbox"/> Mercury or Mercury Containing Compounds	
<input type="checkbox"/> Inorganic Liquids*	
<input type="checkbox"/> Corrosive:	<input type="checkbox"/> Acidic ($\text{pH} \leq 2$) <input type="checkbox"/> Alkaline ($\text{pH} \geq 12.5$)
<input type="checkbox"/> Reactive	
<input type="checkbox"/> Biohazardous	<input type="checkbox"/> Sharps
<input type="checkbox"/> Solid Waste	
<input type="checkbox"/> Radioactive (isotope/activity):	
<input type="checkbox"/> RCRA Toxic or Listed Waste: EPA Waste Code	
Hazardous Constituents:	
.....	
.....	
.....	
Amount collected:	
Room #	Start Date:
& Dept.: CHM	End Date:
<small>*Act 491 Part 121 Regulated Liquid Industrial Waste</small>	
HAZARDOUS WASTE	





The Green Chemistry Commitment

TRANSFORMING CHEMISTRY EDUCATION

Toxicology content in an existing course

CHM321-Environmental Chemistry

CHM245-247-Organic I and II

CHM461-463-Biochemistry

CHM115-116-Introductory Chemistry?

Environmental Sciences:

CHM321-Environmental Chemistry

CHM322-Environmental Chemistry

ENV201—Introduction to Environmental studies

CHM 111

Introduction to Green Chemistry

lecture

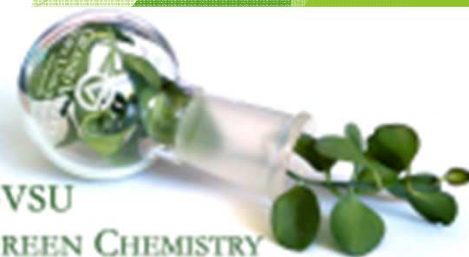
CHM 311

Green Chemistry and Industrial Processes

lecture

- Certification in green chemistry -

- Faculty Research
- Student engagement
- Community engagement
- Partnership with local industry
- Service



Students who seek a **Certificate in Green Chemistry** are required to complete 13-14 credits from the courses below:

- CHM 311 **Green Chemistry and Industrial Processes**
Credits: 3
- CHM 321 **Environmental Chemistry** Credits: 3
- CHM 399 Readings in Chemistry Credits: 1 or 2
- CHM 490 Chemistry Laboratory Internship Credits: 1 to 4
OR CHM 499 Investigation Problems Credits: 1 to 5
(any combination of CHM & 490/499 that add to a total of 3 credits satisfies this requirement)

And one of the courses listed below:

- CHM 322 Environmental Chemical Analysis Credits: 3
- NRM 330 Environmental Pollution Credits: 3
- GPY 412 Global Environmental Change Credits: 3
- ECO 345 Environmental and Resource Economics Credits: 3
- GEO 300 Geology and the Environment Credits: 3
- NRM 451 Natural Resource Policy Credits: 4*
- GEO 445 Introduction to Geochemistry Credits: 4*



Green Chemistry at Michigan Tech



Green Chemistry Commitment

Signed in spring 2013

But started in Fall 2014

Activities to date

- ✧ Department viewing of Green Chem Education Webinar:



Dr. John C. Warner
Founder and C.T.O., Warner Babcock
Institute for Green Chemistry
October 15, 2014, 2pm – 3pm EDT

Green Chemistry: The missing element in chemistry education

- ✧ Plan rescreening for ACS students
- ✧ Scheduled group viewing of next in series: Jane Wissinger, U Minn.

- ✧ Sent organic lab supervisor to Green Chem workshop
- ✧ Hired organic chemist with expertise in toxicology *and* interest in GC.
- ✧ Seminar by Mark Mason, *School of Green Chemistry and Engineering, The University of Toledo: Green Chemistry, an overview of principles and applications.*

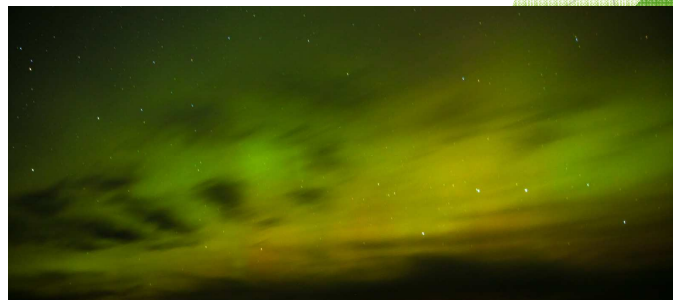
Curriculum updates

Current

- ✧ Green chemistry graduate seminar course- spring 2013
- ✧ New organic lab experiments
 - ✧ Oxidation of Alcohols Using a Clayfen Catalyst
 - ✧ Diels-Alder Reaction in Water
- ✧ Green Chem and expanded climate chemistry sections in First Year Chem.

Planned

- ✧ Expand green chem course to undergrads, include toxicology.
- ✧ Assess aspects of curriculum appropriate for green chemistry updates



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